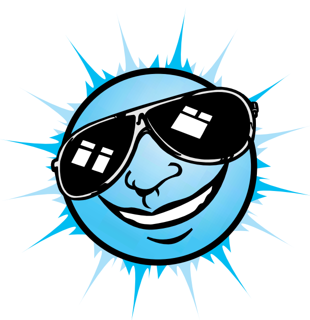
☼ Summer2002

RPM News

▲ Remedial Project Manager News ▲

"Communicating Navy Installation Restoration Program News and Information Among All Participants"

In This Issue



General Electric (G.E.) vs. Environmental Protection Agency (EPA):

Bringing Good Things to Life (But Not Necessarily Ours)

A recent case involving challenges to EPA-created guidance documents in the realm of Toxic Substances Control Act (TSCA) has been making the e-mail rounds as having great import for how we manage our various environmental compliance programs. The case is G.E. vs. EPA (No. 00-1394, United States Court of Appeals District of Columbia (USCADC), May 17, 2002), and the issue was whether an EPA Polychlorinated Biphenyl (PCB) Risk Assessment Guidance was a "rule" as is defined by TSCA, and therefore needed to be created in accordance with the Administrative Procedures Act (APA). The USCADC Circuit held since the Guidance "expresses a change in substantive law or policy (that is not an interpretation) which the agency intends to make binding, or administers with binding effect" that the Guidance was in fact a rule. And therefore "the agency may not rely upon the statutory exemption for policy statements, but must observe the APA's legislative rulemaking procedures." The court came to the conclusion that "the Guidance Document is a legislative rule such that the court does have jurisdiction to entertain G.E.'s petition and the Document should not have been issued without prior notice and an opportunity for public comment." See: *http://laws.lp.findlaw.com/dc/001394.html*

The result in this case should not be surprising. Similar holdings occurred in the Clean Air Act arena in Appalachian Power Company, et al. v. EPA (No. 98-1512, USCADC, April 14, 2000). When EPA publishes guidance, it typically avoids the problems the court found in this TSCA Guidance by making clear that the guidance is not binding, and there is a significant degree of flexibility present in the terms of the guidance that gives both regulator and regulatee the space necessary to make smart compliance decisions on a case-by-case decision. As the court points out in this case, EPA has successfully done this in "the data in the Agency's Integrated Risk Information System (IRIS), which are not subject to the requirements of notice and comment rulemaking." But, on the other hand, when EPA's guidance fails to retain this flexibility, courts have little resistance to view such as regulations in the disguise of "guidance" that require the normal, Federal Register-based, notice and comment before going final.

For we who work for federal agencies this case poses some special challenges. First, if we are on the receiving end of an EPA-created "guidance" that really is a regulation that has not been properly promulgated per the APA, it's certain (as in 100%) we won't be able to mount an attack via the courts like G.E. Instead, because federal agencies can't sue each other, our forum will likely be the EPA administrative hearing process (e.g., 40 CFR Sec. 22) and E.O. 12146 and E.O. 12580 which establish Department of Justice (DOJ) and Office of Management and Budget (OMB), respectively, to resolve intra-federal agency disputes.

RPM NEWS

Remedial Project Manager News

Published By
NFESC

Using Appropriated Funds

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Second, in the realm of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) there are extra special challenges. CERCLA Sec. 120(a), the language which waives federal sovereign immunity to the requirements of CERCLA, says:

Sec. 9620. Federal facilities
(a) Application of chapter to Federal Government

(1) In general
Each department, agency, and instrumentality of the United States (including the executive, legislative, and judicial branches of government) shall be subject to, and comply with, this chapter in the same manner and to the same extent, both procedurally and substantively, as any nongovernmental entity, including liability under section 9607 of this title. Nothing in this section shall be construed to affect the liability of any person or entity under sections 9606 and 9607 of this title.

(2) Application of requirements to Federal facilities
All guidelines, rules, regulations, and criteria which are applicable to preliminary assessments carried out under this chapter for facilities at which hazardous substances are located, applicable to evaluations of such facilities under the National Contingency Plan, applicable to inclusion on the National Priorities List, or applicable to remedial actions at such facilities shall also be applicable to facilities which are owned or operated by a department, agency, or instrumentality of the United States in the same manner and to the extent as such guidelines, rules, regulations, and criteria are applicable to other facilities. No department, agency, or instrumentality of the United States may adopt or utilize any such guidelines, rules, regulations, or criteria which are inconsistent with the guidelines, rules, regulations, and criteria established by the Administrator under this chapter.

Typical with most waivers of federal sovereign immunity, Sec. 120(a)(1) has a broad and explicit requirement to follow both the substance and procedural requirements of CERCLA. But special to CERCLA, and unlike most other environmental laws, Sec. 120(a)(2) goes out of its way to say that federal agencies must act consistent with and NOT inconsistent with EPA "guidelines, rules, regulations, and criteria" to the extent such "guidelines, rules, regulations, and criteria are applicable to other facilities." This requirement doesn't mean we still don't have a "G.E./TSCA-type argument" that a given piece of CERCLA "guidance" is really an improperly promulgated EPA regulation. But once such "junk guidance" is vacated or (more likely) reformed, and is reissued as "true guidance" it does fairly mean we have a specific statutory obligation to act consistent with it and not inconsistent, with it.

Where EPA has promulgated "true guidance" but such guidance treats federal facilities differently than other facilities, we still have an argument that under Sec. 120(a)(2), we have the ability to not comply. But it should be recognized, especially in the realm of CERCLA, that the vast majority of EPA "true guidance" is of benefit to us when dealing with either EPA Regions or States. Typically this is seen in the area of human health risk assessments where the services follow EPA's Risk Assessment Guidance for Superfund (RAGS) in making the pivotal determination of whether a site requires cleanup, and if so, to what extent. Such "true guidance" and our obligation under Sec. 120(a)(2) to act consistent and not inconsistent with it, is of great benefit when dealing with regulators who (surprise!) would rather rely on politics to make cleanup decisions and not science.

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New Course Established: Munitions Response Site Management

Remedial Project Managers (RPMs) facing the daunting prospect of encountering munitions and explosives of concern (MEC)—to include unexploded ordnance (UXO)—incidental to construction or contaminant remediation once had to rely on advice from other Navy Service RPMs, and then reluctantly graduate from the “School of Hard Knocks.” Coming to their rescue, the Civil Engineer Corps Officers School (CECOS) will soon stand up a new course tailored to meet the needs of the Navy’s RPM, Remedial Technical Manager (RTM), Base Realignment and Closure (BRAC) Environmental Coordinator (BEC), Regional Officer in Charge of Contracting (ROICC), Engineer in Charge (EIC), or the Navy Technical Representative (NTR) who is currently working on, or may one day encounter, a project with known or suspected MEC.

MEC exists on thousands of acres of Navy property that may have once been used to manufacture, store, handle, develop and test, transship, or treat munitions. These sites may now be non-operational ranges or munitions disposal areas. They can be properties leaving Navy control such as those subject to BRAC, or even acreage put to another use but retained by the Navy. As pressure mounts to remove MEC to allow for re-use, or to make a contaminated site safe for current use, RPMs are faced with working on a new and unique contaminant with a new set of rules, a different workforce, specialized equipment and technology, and an unprecedented level of scrutiny from Congress, the Department of Defense (DoD) and the Navy, as well as Federal and State regulators.

The CECOS course designed to meet these needs is titled “Munitions Response Site Management.” It will include classroom instruction as well as practical exercises, giving graduates not only the fundamentals they will need, but also a greater confidence in dealing with MEC contaminants and contractors, as well as interested project stakeholders.

CECOS intends to offer the course in Norfolk (22-24 October), and Honolulu (10-12 December) this calendar year. Next year will likely bring three or four additional offerings. Course instructors are Ms. Cindy Turlington of Chief of Naval Operations (CNO) N45, Ms. Amy Walker of Naval Facilities Engineering Service Center (NFESC), and Mr. Doug Murray of Engineering Field Activity (EFA) Northwest. Classes are limited to 25 students.

For additional information and to register go to: https://www.cecos.navy.mil

Training topics include:

1. MEC basics such as how munitions are constructed and how they operate
2. Relevant environmental, DoD, and Navy regulations and policies
3. Roles and responsibilities of agencies and contractors involved with MEC projects
4. The various types of detectors and how they function, and how their data is interpreted and used
5. Key features of an MEC quality assurance and quality control program, including development of relevant data quality objectives
6. Key elements of an MEC hazard communication/public involvement strategy
7. How the historical record search and the archive search report is used as a tool in the Preliminary Assessment project phase
8. The Conceptual Site Model as a tool in the Site Investigation process
9. How to conduct a screening hazard assessment, including the data required to support such a screen
10. Some of the basic rules of explosives safety
11. The investigation and remediation phases of the projects, to include the major elements involved
12. How an MEC project incorporates the Feasibility Study and Records of Decision, or other decision documents
13. The steps required for a typical MEC project in order to achieve site closeout and property transfer
14. Critical aspects of long-term management applicable to MEC projects

Basewide Long-term Groundwater Monitoring Optimization

Former NAS Dallas, Texas

Naval Air Station (NAS) Dallas occupies 877 acres in the center of the Dallas-Fort Worth metropolitan area. In 1993, the Base Realignment and Closure (BRAC) commission recommended NAS Dallas for closure. Southern Division's (SOUTHDIV's) Comprehensive Long-Term Environmental Action Navy (CLEAN) III contractor, Tetra Tech NUS, Inc. (TtNUS) is currently completing Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and post-RFI services. To assess the site, over 300 monitoring wells have been installed. To date, traditional low-flow sampling techniques have been used to sample the wells. Each sampling event required the use of several sampling personnel for several weeks. Additionally, low-flow sampling equipment (i.e., pumps and samplers) were mobilized for each sampling event. The sampling generated a considerable volume of purge water that required handling and disposal as waste.

Figure 1.
Left: Typical passive diffusion bag (PDB) sampler with polyethylene mesh and srainless steel weight

Right: Typical Hydrasleeve™ Sampler with weight attached to bottom

TtNUS was tasked by SOUTHDIV to optimize the basewide groundwater monitoring network. Therefore, the goal was to maximize the efficiency of the groundwater monitoring program while minimizing the cost. As a part of the optimization, the entire program was evaluated including the number of monitoring wells sampled, the frequency of sample collection, analytical requirements, and the duration of the sampling program. The optimization was performed in accordance with the Navy document entitled, "Guide to Optimal Groundwater Monitoring" (January 2000). One of many successful outcomes of the study included a reduction of the number of wells sampled, from over 300 to less than 120. The reduction in number of wells sampled was proposed in a Basewide Water Sampling Work Plan, which was approved by the Texas Natural Resource Conservation Commission (TNRCC) and Environmental Protection Agency (EPA).

Groundwater sampling procedures were also evaluated. As a result of this evaluation, a phased implementation of Passive Diffusion Bags (PDB) and HydraSleeve™ sampling technologies to reduce low-flow sampling techniques is under way (Figure 1). This implementation is expected to reduce the expenses associated with labor, equipment and disposal for sampling a large number of wells yet continuing to collect representative groundwater samples.

Water-filled PDB samplers offer a relatively inexpensive yet suitable alternative method to low-flow purge/sampling for collection of volatile organic compound (VOC) samples from monitoring wells. The use of PDB samplers is based on the principle of molecular diffusion of the VOCs from the groundwater across a semi-permeable low-density polyethylene (LDPE) sampler "bag" (sample chamber). The bag is sealed at one end and at the other end contains a Teflon® opening, which allows the bag to be pre-filled with deionized water. PDB samplers are attached to a weight and stainless steel wire and suspended inside the monitoring well. Once the sampler is installed, it equilibrates with the groundwater over a specified period of time (a minimum of 2 weeks). The sampler is then removed from the well and the collected groundwater is transferred to 40-milliliter sampling vial supplied by the analytical laboratory and shipped to the laboratory for subsequent analysis. Some of the advantages of diffusion sampling include:

A minimal amount of field equipment is needed. There is no need to collect and monitor water quality parameters (e.g., pH, conductivity, temperature, and turbidity) before sample collection.

Bailing and pumping is eliminated. So no purge water is generated, thus little to no Investigative Derived Waste (IDW) is generated. The sample is collected at a specific vertical interval within the well.

HydraSleeve™ sampler, an emerging groundwater sampling alternative, provides a relatively inexpensive alternative to low-flow/purge sampling for the collection of samples where contaminants of concern (COCs) other than VOCs are required. HydraSleeve™ samplers are based on similar assumptions as PDBs, however, because the HydraSleeve™ collects groundwater in a different manner than the PDBs, ALL compounds can be sampled and analyzed.

The HydraSleeve™ sampler is a low profile collapsible sampler that has a check valve opening at one end and a weight at the other end (Figure 1). The HydraSleeve™ sampler is lowered into the well at the target sampling zone and left in place until the water in the sampler equilibrates with the groundwater in the well over a specified period of time. The sampler is then deployed by raising and lowering it in the well allowing water to enter the check valve and the bag. The HydraSleeve™ sampler is then removed from the well and the samples are containerized, shipped, and analyzed by the laboratory as any other groundwater sampler. The advantages of the HydraSleeve™ are similar to the PDB.

The use of these two new technologies, PDB and Hydrasleeve™, shows potential for dramatic cost avoidance without compromising data quality or sampling objectives.

The Texas Natural Resource Conservation Commission (TNRCC) issued a draft RCRA Permit for NAS Dallas in February 1992. As a part of this process the TNRCC has required a long term monitoring plan be implemented. TtNUS, on behalf of the Navy, is working closely with the TNRCC and the EPA to optimize the monitoring program at the site.

Over 300 monitoring wells have historically been sampled. Six rounds of basewide sampling have been conducted over the past 4 years. The challenge was to reduce the labor, equipment, and waste disposal expenses associated with groundwater sampling.

To reduce the expenses associated with labor, equipment, and disposal, PDB and HydraSleeve™ sampling technology is currently being evaluated to determine if it can be used in place of low-flow sampling techniques. PDB/HydraSleeve™ sample technology can provide a cost avoidance from $275 to $600 or up to 70% of costs per sample due to the decrease in or elimination of time, equipment, and IDW required to sample each well. Review of the goals of the groundwater monitoring program reduced the number of wells sampled and the parameters for analysis.

Use of innovative groundwater sampling technologies is expected to enable cost avoidance associated with labor, equipment usage, and disposal of purge water without compromising data quality or sampling objectives. Comparison of data collected from PDB/HydraSleeve™ samplers is currently being compared to historic analytical data and low flow samples collected side-by-side to determine whether further implementation of this technology will proceed.

Innovative technologies can be used to save overall time and provide cost avoidance without jeopardizing quality.

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Alternative Restoration Technology Team (ARTT)

The ARTT is a Naval Facilities Engineering Command (NAVFAC) workgroup made up of the Engineering Field Divisions/Activities (EFD/As), Chief of Naval Operations (CNO), Commandant of the Marine Corps (CMC), NAVFAC Headquarters (HQ), and Naval Facilities Engineering Service Command (NFESC) whose primary goals are to identify barriers to the implementation of innovative technologies and methods and to recommend changes to address these barriers. So far this year, the ARTT has focused on re-evaluating its goals, providing input to the Navy Research & Development (R&D) community on needs requirements, working with various Environmental Security Technology Certification Program (ESTCP) and YO817 projects and proposals, and subscribing to the Remedial Information Management System (RIMS) - an interactive web-based database that provides a comprehensive listing and independent evaluation of over 800 remediation technologies.

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Chlorinated Source Zone Remediation Technologies

Introduction

Source zone remediation technologies have been emerging over the past 20 years, and much progress has been made in the innovation and development of these technologies. However, few of these technologies have proven to be fully successful in large-scale applications. Also, legal, regulatory, and societal pressures to quickly remediate contaminated sites often does not allow practitioners the luxury of gaining a full understanding of the science behind the technologies. As a consequence, Remedial Project Managers (RPMs) must make decisions to commit considerable resources based on incomplete information. As these technologies are applied, lessons are learned through a combination of trial and error and scientific understanding, both of which are important processes that advance the state of the practice.

The current state of the practice is that, despite the development of a long list of technologies and the expenditure of hundreds of millions of dollars on many sites across the United States, few (if any) sites have been remediated to drinking water standards or background levels. However, some successes have been achieved in containment of sources, reduction of mass in sources, reduction of groundwater concentrations, and reduction of risk. Also, new technologies and better understanding of existing technologies continue to offer the potential for more complete source remediation. This article discusses the advantages and limitations associated with several source zone remediation technologies, with a focus on the expectations for source removal and control. These, along with cost and site cleanup goals, must be factored into the decisions made by RPMs regarding the selection, design, and implementation of a removal approach chosen for a site.

Background

The *source zone* is the area that has been in contact with Non-Aqueous Phase Liquid (NAPL) or nearby areas with high concentrations. This zone could contain free-phase mobile NAPL, residual NAPL, or geologic materials contaminated by diffusion from nearby NAPL, and is sometimes considered the area with >10% of contaminant solubility. The *plume* is the contaminated groundwater emanating from the source zone. Though easy to define in theory, it is often difficult to distinguish the plume from the source in practice.

Many chlorinated solvent plumes have source zones, but not all. It is possible to generate a plume by releasing water contaminated with chlorinated solvent. Such a plume where no NAPL is released has no real source zone, and would be much less persistent than one with a source zone. Most plumes likely do have some kind of NAPL source, but in many cases that source can be hard to find (dissolved plumes without source zones appear to be relatively uncommon.) Still, not all chlorinated solvent plumes have a Dense Non-Aqueous Phase Liquid (DNAPL) source. In pure form, most chlorinated solvents of concern are denser than water. However, chlorinated solvents mixed with lighter petroleum hydrocarbons commonly result in a Light Non-Aqueous Phase Liquid (LNAPL), as is the case at fire training facilities. At some sites, a release is too small to penetrate the water table, even where relatively pure chlorinated solvents are released. These sites where DNAPL does not penetrate the water table are less problematic to remediate than DNAPL sites where the aquifer has been penetrated.

The DNAPL Problem

Several issues associated with DNAPL remediation present considerable challenges to RPMs and their contractors. Probably the most significant issue is source area characterization. DNAPL distribution can be very complex, as it can migrate downward, following intricate preferential pathways. Although gravity is the driving force behind DNAPL migration, relatively small geological heterogeneities can have significant effects on the specific paths taken by the DNAPL. For example, DNAPL may migrate downwards to a clay layer and move nearly horizontally for hundreds of feet following a narrow erosional feature. It then may encounter a discontinuity and continue downward, far from the original release point. This and similar scenarios can result in significant DNAPL mass in a deeper aquifer apparently removed geographically from the source.

Finding, delineating, and understanding source areas often requires resolution on the order of a few feet. No technology currently available provides that kind of resolution. However, several technologies can help characterize the source area. For example, conventional soil and groundwater sampling are useful, but rarely affordable in sufficient resolution. Soil-gas surveys can be a cost-effective way to locate release points and vadose zone contamination, but often correlate poorly with subaqueous contaminant distribution. The direct-push membrane interface probe offers a reasonable approach to delineating high concentrations near a source area, but it still requires intrusive sampling. Partitioning Interwell Tracer Tests (PITTs) are useful but are expensive and have limitations. Determining the proper extent of source zone delineation reduces to competition among the need for exact delineation, available characterization technologies, and cost.

Another significant issue (especially for DNAPL) is matrix diffusion. In any heterogeneous geology, chlorinated compounds will diffuse from more permeable zones (strata or fractures where higher concentrations exist) into less permeable zones. The effectiveness of any technology dependent on movement of some reactant or the contaminant will be limited in this low-permeability material. At most DNAPL sites, contaminants have had tens of years to diffuse into the geologic matrices, and will require hundreds of years to diffuse back out. Figure 1 shows an example of a DNAPL that migrates downward through a more permeable aquifer and pools on a low-permeability clay layer. Over time, much of the DNAPL mass may diffuse into the clay; this can be an even more severe problem in fractured bedrock. Remediation of residual contamination in the overlying permeable aquifer may be fairly easy, and some remediation of the top of the clay layer may occur, but remediation of the material diffused deeper into the clay can be very difficult and very slow. This is the primary cause of rebound so commonly observed in DNAPL remediation. Initial success is often achieved in removing contaminant from the higher permeability channels, and for a time substantial declines in groundwater concentrations may be observed. Over time, however, the contaminant mass in these low permeability areas diffuses back into the higher permeability channels and is again observed in the groundwater.

Biodegradability of the contaminant mass is also an important issue, as most DNAPLs are quite persistent in the environment. Chlorinated solvents are hydrocarbons that have been oxidized by the addition of chloride molecules. Although these chlorinated hydrocarbons have useful properties (i.e., the oxidized material is much less flammable and safer to work with than the parent hydrocarbon), they also are more dense, and much less biodegradable than their parent molecules. Short-chain hydrocarbons like ethylene and ethane (i.e., LNAPLs) easily biodegrade under a wide variety of conditions. Their chlorinated (i.e., DNAPL) counterparts, trichloroethylene and trichloroethane are much less biodegradable, and degrade only under very specific conditions.

Remediation

Complete remediation of DNAPL sites remains an elusive goal because of the previously mentioned challenges. It has been proven possible to contain the source at many sites, but containment is a long-term commitment, and complete remediation only occurs when the source zone is depleted. However, many containment technologies do little to accelerate this depletion; and, despite the fact that several technologies have been proven to remove mass from the source zone, complete source removal has never been demonstrated. Without near complete source zone removal, cleanup to low-level concentrations in groundwater cannot be achieved. Partial source removal can either accelerate the ultimate dissolution of the source, resulting in cleanup sooner, or reduce the mass transfer of contaminants into the aquifer, lowering groundwater concentrations and reducing plume size. Either of these may be useful accomplishments. Unfortunately, the time required for these benefits to be seen at most sites is longer than site remediation has been practiced, so theoretical models must be relied upon to understand and demonstrate these benefits.

From a practical side, the cost benefit also must be considered. If partial source removal is not successful in achieving groundwater clean up goals, the cost of follow-on treatment or monitoring may be similar to the project cost *without the source treatment*. To make the best choices, RPMs need to be aware of the state of the practice of source zone treatment technologies, both advantages and limitations. Perhaps more importantly, RPMs need to understand that they are an integral part of the advancement of the state of the practice in this business. A well-designed, well-documented implementation of a remedial technology is valuable information and advances the practice independent of the outcome.

Source zone remediation can be divided into two treatment approaches, source containment options, and NAPL mass removal. The division between these approaches is not always clear; some technologies can remove mass *and* provide containment. In this discussion, technologies will be defined by their primary purpose. Also, no technology currently has been proven to provide complete source zone removal, so this approach is often referred to as "partial source removal."

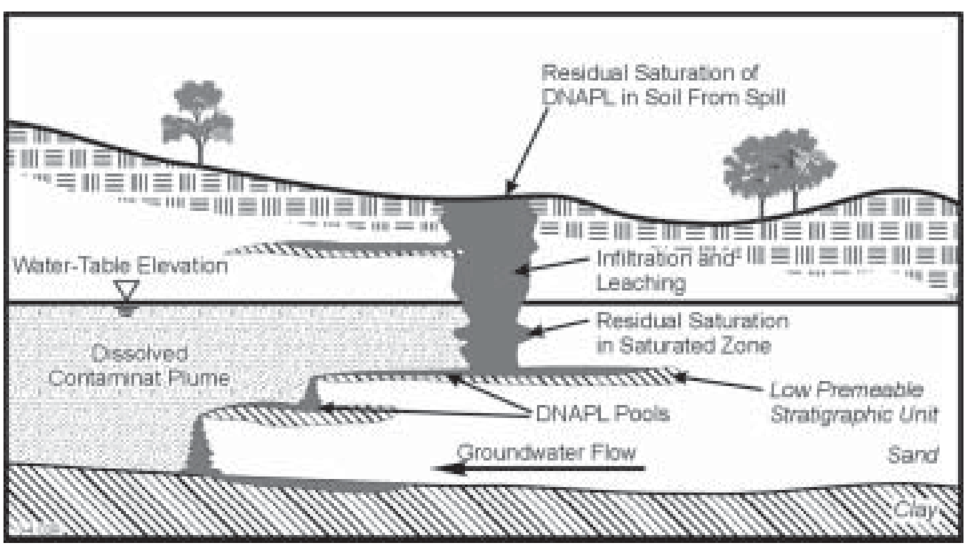

Figure 1. Conceptual model of potential vertical distribution of DNAPL

Containment Options

Containment options are technologies designed to stop or reduce the flux of contamination from a source zone into groundwater in order to reduce the size and concentration of the dissolved plume. Containment technologies are not designed to substantially reduce the mass of contamination in the source zone, or the time over which the source zone will persist. Experience has shown that containment is possible by matching site-specific conditions with the advantages and limitations of the various technologies available. However, it is challenging to ensure containment because a complete understanding of the site-specific hydrogeology is necessary for an effective design. Typically, containments have failed because of a limited understanding of groundwater flow. RPMs should be aware of unrealistic expectations of even a successful containment approach. After containment is achieved, the dissolved plume will be cut off and eventually disappear, but it may take years for that effect to be observed in groundwater monitoring data. The same diffusion process by which the source zone releases contaminants to the dissolved phase also may occur from sorbed soil sites in the dissolved plume, resulting in rebound of contaminant concentrations. Some barriers may result in decreased flow into the plume, again prolonging the dissolved plume life. Finally, in some settings, such as fractured rock, practical containment has not proven achievable. In general, however, more success has been achieved with source containment than source mass removal.

Pump-and-treat (P&T) technology is the most common containment approach. P&T was once thought to be an effective option for groundwater remediation. However, experience has shown that concentrations commonly rebound after temporarily being reduced by P&T applications, resulting in a need for continued remediation. P&T activities in the contaminated plume are ineffective at reducing or removing the NAPL source. Typically, for successful plume treatment, some degree of removal or treatment of the source is required; therefore, plume treatment successes using P&T are rare. Today, P&T is recognized as a containment technology.

Permeable reactive barriers (PRBs) can be a successful containment technology. In iron filing walls, chlorinated solvents are dechlorinated through abiotic reduction. Fouling, which was originally thought to be a difficulty, is not a problem. The major limitation to the PRBs is that water often flows over, under, and around, but not through the barriers. This occurs for several reasons: the barrier is not deep or long enough, installation challenges may lead to bridging problems, and the groundwater hydraulics typically are not understood well at the time of installation. The primary challenge has been to develop a good understanding of local hydrology. Despite difficulties, several notable examples of successful PRB installations are in operation today. In addition to iron walls, a variety of other technologies may be used in a permeable barrier application, such as aeration trenches and biological barriers. (An example of a biological barrier is the use of a compost or bark mulch wall to intercept groundwater flow and remove the chlorinated solvents).

Bioremediation of chlorinated solvents is usually considered a containment technology. The most widely practiced approach to bioremediation is anaerobic dechlorination, where a carbon source is added to the aquifer and biological dechlorination is stimulated. For example, with sufficient available carbon, perchloroethylene (PCE) can be reduced to trichloroethylene (TCE), TCE to *cis*-1,2-DCE, *cis*-1,2-DCE to vinyl chloride, and finally vinyl chloride to ethene and ethane. Other pathways are possible. In source treatment, the carbon source is injected in or near the source zone causing the dissolved contaminant to dechlorinate. In a successful application, the rate of dechlorination is adequate to prevent further release of chlorinated solvents from the source zone and into the groundwater plume. The process must be maintained over the long term to ensure degradation for as long as the source remains. Some evidence exists that this process may accelerate treatment of the source zone; however this evidence is controversial, and bioremediation presently is recognized primarily as a source containment option.

Phytoremediation, another containment technology, also has its limitations. The removal rates achieved by phytoremediation are seasonal in most regions, and the technology is only applicable for shallow water tables. Phytoremediation requires space and long-term care and the vegetation may take years to become established.

Monitored Natural Attenuation (MNA) is a remedial program that relies on a series of natural processes without applying an engineered remedy. At some sites, MNA may result in sufficient concentration reductions to effectively contain the source zone. The effectiveness of these processes depends on the dissolution of the NAPL sources and natural mechanisms acting in groundwater. Although MNA may not provide sufficient treatment at many sites, it is important to understand natural attenuation mechanisms in order to effectively evaluate candidate-engineered remedial technologies. The relative benefit of candidate-engineered remedies can be compared to MNA (as a baseline option) to ensure that cost benefits of the engineered system support the decision to implement the active remedy.

Mass Removal Options

Mass removal options are technologies designed to remove a substantial portion of the NAPL mass, measurably reducing the time to reach maximum contaminant level (MCLs), when compared to an approach like MNA. Experience and modeling show that much (if not all) of a NAPL source must be removed to make a significant difference on plume length and concentration over a timeframe measured in decades. RPMs often face the issue of weighing the cost of performing mass removal versus the benefits gained. If partial mass removal does not result in attainment of MCLs or other remedial objectives, some form of containment may still be necessary. The RPM then must weigh the value of a substantial investment in partial mass removal against the cost of long-term containment.

Technologies that have been applied for mass removal of NAPLs can be divided into three general groups. The more aggressive and usually more expensive technologies include in situ oxidation, surfactant or co-solvent flushing, and in situ thermal treatment. Less aggressive and less effective treatments for source removal include air sparging and groundwater circulating wells (GCWs). Although air sparging has been demonstrated as an effective plume treatment option, air sparging and GCWs are often mistakenly selected for source removal and result in ineffective source treatment. Finally, DNAPL or LNAPL free product recovery can be considered less effective for achieving complete source removal, but is an approach that is commonly required.

In particular, the usual objective of the more aggressive technologies is to remove sufficient mass to substantially reduce the flux of contaminants to groundwater. Although this is a worthwhile objective, few well-documented successes exist. Particularly with DNAPL sites, it is not clear that any large DNAPL sources have been remediated to a level sufficient to significantly reduce the time required to return groundwater to MCLs or similar standards. It also is true that many of these technologies have been shown to remove substantial NAPL mass. The dilemma is the apparent need to remove most — if not all — of the mass to achieve and maintain low concentration drinking water standards and MCLs.

Surfactant-enhanced recovery is an in situ treatment process (shown in Figure 2) that typically is coupled with a conventional P&T system in an effort to expedite subsurface remediation. Increasing DNAPL aqueous solubility by using surfactants can potentially reduce remediation time. However, the same effect that makes surfactants successful (i.e., reduction of interfacial tension) also increases the potential for downward migration of the DNAPL. Aboveground treatment of extracted water, surfactant cost, and recycling issues make this an expensive process.

In situ oxidation is a technology that is being commonly applied. When oxidizing agents (or oxidants) such as hydrogen peroxide, Fenton's reagent, or potassium permanganate are properly contacted with contamination, many organic contaminants can be destroyed successfully. The difficulty observed in practice is gaining adequate contact between the oxidant and the contaminant. In a recent study funded by Environmental Security Technology Certification Program (ESTCP), it was found that most field applications of in situ oxidation at Department of Defense (DoD) installations did not achieve remedial goals.

Groundwater circulation wells, also known as recirculation wells, were developed in Germany and brought to the U.S. in the early 1990s. Vendors initially claimed that GCWs were more effective, more efficient, and less expensive than P&T designs. GCW demonstration sites proved these earlier claims wrong. The major benefit to choosing a GCW treatment system over P&T is that all components are below ground, which can consequently expedite the permitting process.

Air sparging once was thought to induce airflow in groundwater aquifers similar to the flow regimes observed in basin reactors. Today, it is known that bubbles are not formed in the saturated zone. Instead, air moves through a series of relatively permeable channels, unlike the bubbles formed in water. Homogeneous conditions typically yield a 2-m radius of influence, whereas nonhomogeneous conditions yield unpredictable flow distribution patterns. NAPL recovery of either the light or dense fluids (LNAPL or DNAPL) has proven to be unpredictable. Generally, 5-10% (realistic) to 30% (maximum) of LNAPL free product is recoverable via liquid phase removal methods. There is little correlation between the free-

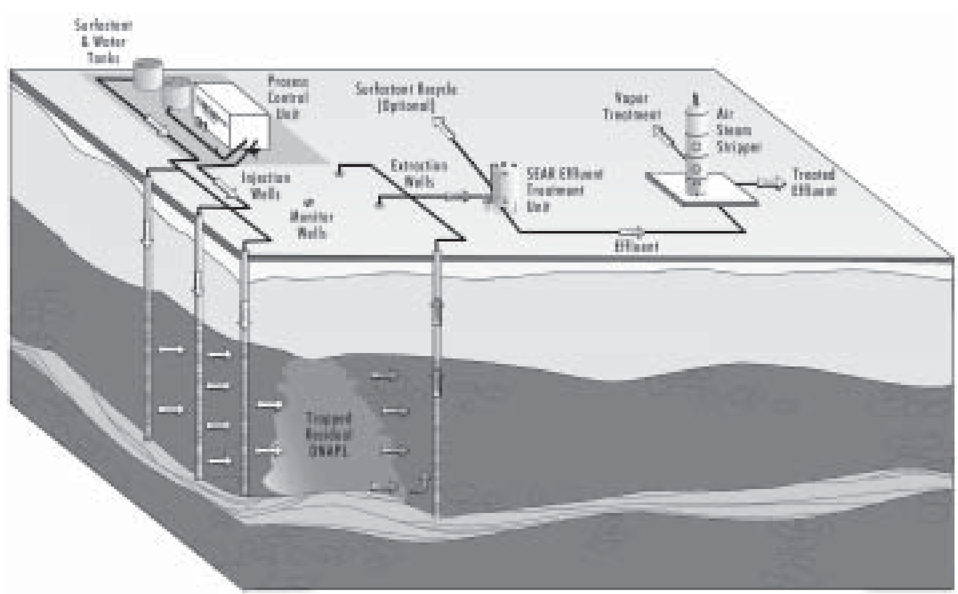

Figure 2. Example of surfactant enhanced DNAPL recovery

product thicknesses observed in a well and the amount of LNAPL "floating" on the water table. In the case of DNAPL, recovery is even more difficult because adequately determining the extent and small-scale distribution of DNAPL, and therefore determining the locations at which to implement removal techniques, presents substantial challenges.

In situ thermal treatment is possible using a variety of technologies. The principle behind this approach is to increase aqueous solubility, steam strip, accelerate abiotic or biological degradation, or decrease NAPL viscosity in order to allow treatment. The most common approach is to heat the aquifer to the boiling point of water and steam strip the contaminants. An important difference between this technology and the other source treatment technologies is that some treatment is accomplished by thermal diffusion of heat rather than depending on fluid advection and aqueous phase diffusion. This approach can allow more efficient treatment of contamination diffused into low permeability materials. Examples of in situ thermal technologies include steam injection, joule heating (insertion of electrodes and passing a current through the soil using the soil's resistive capacity to generate heat), advective heating from hot wells, or a thermal blanket. In situ thermal treatment was one of the first commercially available source removal technologies, but has proven difficult to verify in the field. Collection of hot soil and groundwater samples has resulted in unrealistic evaluations, and the potential for contaminant spreading has been a concern.

What RPMs Need to Know

Despite the evolving nature of the source zone remediation business, RPMs will be required to make decisions regarding the most beneficial approach to their NAPL sites. To make the best decisions, the RPM need to be aware of several issues, including the following:

1. What kind of site is it? Is DNAPL or LNAPL present? Is there a dissolved plume without a source zone? It is not necessary to fully investigate the plume and source zone to be able to answer these questions, but it is critical to understand these issues when developing a remedial strategy.
2. What are the remedial action objectives, and how do they compare to what can realistically be achieved given the current state of the practice?
3. If a mass removal technology is selected for implementation, what are the implications of partial source removal and non-achievement of remedial action objectives? Are there plans and considerations of the possible costs of follow on treatment or monitoring?
4. If implementing a mass removal technology, is there a realistic view of the associated risks and the probable outcome? Is this view based on full-scale data from other similar sites?
5. If a mass removal technology is selected for implementation, have the costs and problems of long-term operations and monitoring been realistically considered?
6. If a mass removal technology is selected for implementation, is there a solid understanding of the site-specific hydrogeology, risk of implementation, and the probability of success?

This work is being performed at the edge of the practice's understanding of remedial technology. A well thought out, well-designed approach that does not meet remedial action objectives should not be considered a failure. The only failures are failures to document and understand the results of the work.

The Navy is currently undertaking an initiative to develop a decision matrix that grades various source removal technologies based on performance and cost, in the context of site conditions and remedial goals. To develop this matrix, case studies where DNAPL source removal has been attempted or implemented will be gathered and the data will be evaluated. The compilation will highlight advantages and limitations for each technology applied. The ultimate goal of the decision matrix will be to provide RPMs and environmental managers with detailed information on source zone remediation technologies. This will aid the decision makers in determining the technical and financial feasibility of a particular source zone remediation approach for a specific site. Ms. Carmen A. Lebron from the Naval Facilities Engineering Service Center (NFESC) will be leading this effort.

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Portions of this article were derived from the Remediation Innovative Technology Seminar (RITS) presentation "Knowledge Exchange - Source Removal Technologies" and text by Dr. Robert Hinchee from Battelle.

New Laboratory Detection and Reporting Limit Issue Paper Available

Have you ever wondered why you get data with higher than expected laboratory reporting limits? Have you had to redo sampling because of it? There is a new issue paper available to you to help explain why lab detection limits are higher than expected and what you can do to better ensure that you achieve the detection limits needed to make decisions at your site. The paper, titled "Laboratory Detection And Reporting Limit Issues Related To Risk Assessments," provides an overview of what may be required to achieve data quality objectives for either Human Health or Ecological Risk Assessments (ERA).

While this paper is not intended to transform the reader into an analytical chemist, it does provide a brief discussion of how environmental samples are processed and analyzed, terminology typically used during analysis and data reporting, and options that are available to improve (lower) reporting limits. It stresses the importance of maintaining close communications with the laboratory so that the lab understands the necessity for achieving data reporting goals and the need to notify the Remedial Project Manager (RPM) if those goals are not being met.

It is very difficult to provide a definitive set of guidelines that will always result in reporting limits that meet the measurement quality objectives. However, by having a better understanding of the available analytical options and a proactive plan for dealing with reporting deficiencies (before all the samples are analyzed and you receive the final data report) it is possible to reduce unusable data sets.

The paper is available at either the Naval Facilities Engineering Command (NAVFAC) ERA Guidance website (*http://web.ead.anl.gov/ecorisk*) or the Human Health Risk Assessment Guidance website (*http://www-nehc.med.navy.mil/HHRA/index.htm*). Both of these sites can be accessed from the Naval Facilities Engineering Service Center (NFESC) website *(http://enviro.nfesc.navy.mil/erb)*.

For more information, contact:

Atlantic Division Operations (LANT Ops)
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Risk Assessment Workgroup (RAW)

The Naval Facilities Engineering Command (NAVFAC) Risk Assessment Workgroup (RAW) was established in FY00 to assist and advise Remedial Project Managers (RPMs) with the human health and ecological risk assessment processes to their sites. The RAW works for consistency and information sharing at remediation sites throughout the Navy by developing and recommending initiatives, methodologies, and strategies that will support the use of sound risk assessment tools and processes and through the sharing of lessons learned and experiences. The goal of the RAW is to improve the consistency and effectiveness of risk assessment efforts across the Navy's Environmental Restoration program.

The Risk Assessment Workgroup includes all Engineering Field Divisions/Activities (EFD/As), NAVFAC Headquarters (HQ), and Naval Facilities Engineering Service Center (NFESC) as well as participants from Chief of Naval Operations (CNO), Navy Environmental Health Center (NEHC), and Space and Naval Warfare Command (SPAWAR) System Center, San Diego (SSC).

The RAW has developed several products to assist RPMs with risk assessments including two guidance websites, one each for ecological risk assessments and human health risk assessments. Either site can be accessed by visiting *http://enviro.nfesc.navy.mil/erb* (When at this web site, select "Navy Support," then "Workgroups," then "Risk Assessment"). Also found on these sites are a number of guidance documents, issue papers, case studies, and risk assessment tools.

Products under development include Guidance for Environmental Background Analysis, Vol I: Soils (completed Apr 02) and Vol II: Sediments (Aug 02); Implementation Guide for Assessing and Managing Contaminated Sediments (Sep 02); Natural Resource Injury Guidance (Oct 02); Environmental Monitoring Guidance (draft Aug 02); and Standard Operating Procedures for Lead Human Health Risk Assessments (Aug 02).

For more information, contact:

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Remedial Options for Addressing Heavy Metals in Small-Arms Range Soils

Introduction

Lead and other heavy metals related to firearms training typically accumulate in small-arms range soils over time. These metals may become an environmental concern because of the potential for personnel exposure to site soils and/or off-site migration of contamination to surface water or groundwater. At active ranges, periodic maintenance may be required to alleviate ricochet or to address environmental concerns. At inactive ranges, range soils may need to be remediated before closure or to restore the site for other uses. Besides range soils, other materials that may contain elevated levels of heavy metals are spent sandblasting grit, sediments, foundry sands, and soil around leaking petroleum underground storage tanks (USTs). The Naval Facilities Engineering Service Center (NFESC) has been working to develop and implement innovative technologies for the remediation of heavy metal contaminated soils, sediments, and waste materials. There are several ex situ technologies available for the treatment of lead and other heavy metals in range soils including soil washing, acid leaching, and solidification/stabilization.

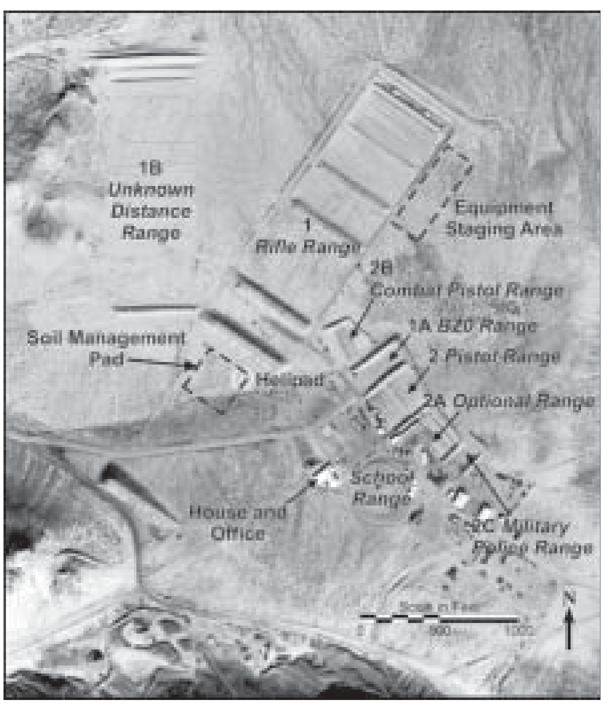

Figure 1. Rifle range configuration.

Site Description

At small arms ranges, there are several management and technical challenges that will arise during each major step of the cleanup process from site characterization, risk assessment, remedial option evaluation, through remedy implementation. Some of these issues will be highlighted based on NFESC's experience with the cleanup of four small-arms ranges at the Marine Corps Air Ground Combat Center (MCAGCC) in Twentynine Palms, California.

The MCAGCC is an active military facility located in the Mojave Desert in south central San Bernardino County, California, about 54 miles north-northeast of Palm Springs. The primary mission of the MCAGCC is to conduct and evaluate live-fire maneuvers and other major training exercises. In support of these missions, MCAGCC maintains a small-arms range complex (Figure 1), which trains more than 10,000 active duty Marines per year for service rifle and service pistol re-qualification. NFESC performed an initial site assessment of the four small-arms ranges at MCAGCC and determined that soil processing was needed to remove particulate lead from the impact berms and overflight areas.

Site Characterization

Small-arms range soils are particularly difficult to characterize because of extremely heterogeneous lead distributions and soil properties. Microscale heterogeneity is introduced by lead particles present in sizes ranging from small fragments to intact bullets. Macroscale heterogeneity is introduced by range maintenance practices such as the periodic re-grading activities that result in a high density of bullets within buried layers of the impact berm. A Remedial Project Manager (RPM) must take into account this variability when planning the site characterization approach. Special sample collection, handling, and analytical protocols should be considered. For example, composite soil samples from bullet pockets and deep within the berm are recommended and particle-size screen-

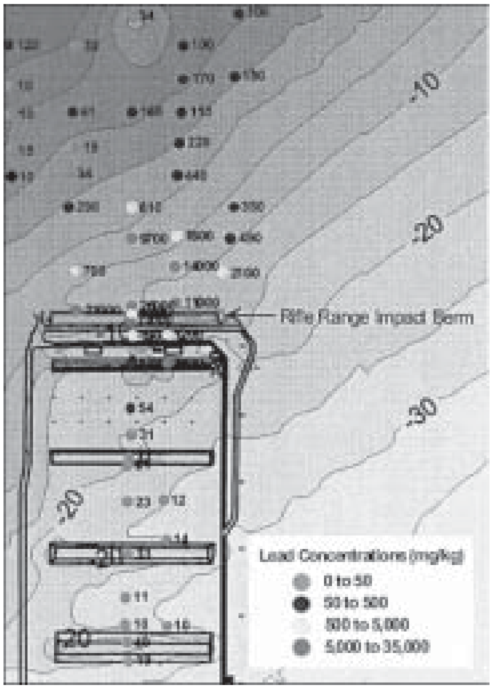

Figure 2. Rifle range characterization results.

ing is often needed to remove bullets and rocks prior to soil sample analysis for total or leachable metals. At MCAGCC, personnel from NFESC collected surface soil samples from small arms ranges based on a random sampling grid for the overflight areas and more targeted, judgment sampling within the berms. The results are shown in Figure 2. The mean lead concentrations in these samples ranged from 45 to 372 mg/kg, with a maximum detected lead concentration of 35,000 mg/kg. The sampling program results indicated that the highest total lead concentrations in the soil were in the impact berms and immediately behind the berms.

Site Risk Assessment

Because the sites at MCAGCC are active military ranges, the development of cleanup criteria based on residential and commercial land use scenarios was not considered to be applicable. Under the U.S. EPA Military Munitions Rule, bullets enter the soil at a range as an integral part of their intended use and the lead-bearing soil at an active range is not subject to regulation as a solid waste. Instead of developing cleanup criteria for future land use scenarios, a soil processing goal was calculated using the California Department of Toxic Substances Control (DTSC) LeadSpread model. This soil processing goal was developed to allow the treated soil to be safely reused at the site to construct bullet backstops. The LeadSpread model is based on five different exposure pathways including dietary intake, drinking water, soil and dust ingestion, inhalation, and dermal contact. The conservative model results indicated that 5,400 mg/kg would be protective of a worker at the site 8 hours per day, 5 days per week.

Remedial Option Evaluation

Bench-scale testing on site-specific soil is essential to evaluate the technical effectiveness of a technology, estimate the cost of application, and avoid potential problems during the field operation. Three technologies were considered for cleanup of the range soils at MCAGCC including soil washing with physical separation, acid leaching with hydrochloric acid, and solidification/stabilization with Portland cement, phosphate, and asphalt. During the berm characterization efforts, NFESC's contractor collected soil to be used in a treatability study. These samples were collected as large-scale composite samples formed by mixing soil from randomly selected bullet pockets and berm locations. The treatability study determined that the site soil was highly amenable to soil washing with lead levels being reduced by over 93% from approximately 24,675 mg/kg to 1,584 mg/kg. During the acid leach test, single stage acid leaching resulted in lead levels from 10 to 11,200 mg/kg. For the more highly contaminated soils that weren't treated successfully with a single stage leach, triple stage leaching was needed to reach levels ranging from 40 to 1,710 mg/kg. For solidification/stabilization, none of the binder formulations tested were able to reach EPA's toxicity characteristic leaching procedure (TCLP) standards for off-site disposal of the material.

Project Implementation

Soil washing with particle separation was selected as the technology of choice because of the successful treatability study, the vendor's technical approach and past experience, and the lowest cost bid. Project implementation included soil management pad construction, soil excavation, soil processing, and metal recycling.

Description	Soil Washing	Disposal
Scope	Includes treatability study, mobilization, soil processing, decontamination, and site restoration	Includes transportation to landfill, solidification/ stabilization, and disposal
Volume Treated	11,700 tons	11,700 tons
Treatment Cost	$66.30/ton	$160/ton
Total Treatment Cost	$776,000	$1,870,000
Cost Recovery	$33,000 (sale of recycled lead)	None
Total Project Cost	$743,000	$1,870,000
Estimated Cost Avoidance: $1,060,000		

Table 1. Estimated Cost Avoidance

Figure 3. Wet Physical Separation Plant used at Twentynine Palms, California.

The soil washing process involved the use of screens, a hydrocyclone, and mineral jigs to treat the soil and separate out lead fragments (see Figure 3). Approximately 11,700 tons or 7,800 cubic yards of soil were processed, which resulted in the generation of approximately 230 tons of recovered metal. The average residual lead level for the processed soil was 1,796 mg/kg, which was well below the 5,400 mg/kg soil processing goal. The washed soil was then used to rebuild the impact berms at the small arms ranges. An important advantage of the soil washing process is that a clean metal product is generated that can be recycled. The recovered scrap lead from the process was sold to a recycler for approximately $33,000.

Summary

The use of soil washing for lead removal from the small arms range soils resulted in a substantial cost avoidance for the Marine Corps. As summarized in Table 1 (see page 13), the estimated cost avoidance was over one million dollars based on soil washing versus the conventional approach of solidification/ stabilization and off-site and fill disposal.

For more information, contact:

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Remedial Action Operation – Long Term Monitoring (RAO/LTM) Optimization Working Group

The RAO-LTM optimization Working Group is comprised of members from the Engineering Field Divisions/Activities (EFDs/As), Naval Facilities Engineering Service Center (NFESC), Naval Facilities Engineering Command (NAVFAC), and Chief of Naval Operations (CNO). The Group has developed guidance documents for optimizing RAO and groundwater monitoring. These documents are available from the NFESC website *(http://enviro.nfesc.navy.mil/erb/support/work_grp/raoltm/main.htm)*. The RAO guidance provides a step-wise optimization process developed based on "lessons learned" from case studies at selected sites. It also provides optimization strategies for several common remediation technologies. A companion guidance document provides strategies for optimizing groundwater monitoring. Based on these documents, Civil Engineer Corps Officers School (CECOS) training courses and Remediation Innovative Technology Seminar (RITS) sessions have been developed and presented to Remedial Project Managers (RPMs).

Currently, the Working Group is participating in multi-agency groups, the Federal Remediation Technologies Roundtable (FRTR) and the Interstate Technology Regulatory Council (ITRC), to facilitate implementation of optimization practices. In addition, the Group is conducting a follow-up study to evaluate effectiveness of the recommendations that were made during the case studies. This follow-up will include evaluation of performance and costs for implementing the optimization recommendations.

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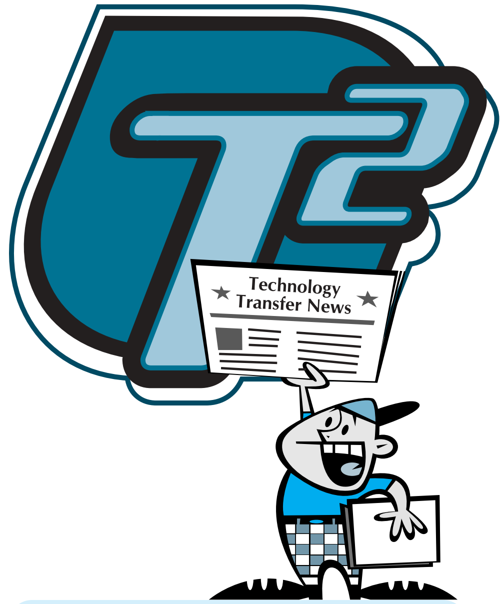
Technology Transfer (T2) News



T2 Web Site Address:

http://enviro.nfesc.navy.mil/erb/restoration/technologies/tech_transfer/main.htm

Welcome to NAVFAC's Technology Transfer (T2) News. This page highlights T2 efforts conducted by the Navy environmental community and supports the Navy's efforts to increase the use of innovative technologies to reduce environmental cleanup costs. In addition to including T2 News in future RPM Newsletters, a web site has been developed, which serves as the source of the most up-to-date NAVFAC T2 information. The web page resides on the Environmental Restoration and BRAC Web Site.

New Policy On Sediment Site Investigation And Response Action Available

This document provides policy on how sediment investigations and response actions shall be implemented in the IR Program. The investigation and cleanup of sediments cannot be treated like soil investigation and cleanup. Sediment contamination is generally more complex. Therefore, extreme care must go into the planning and design of investigations and any corresponding response action. Please visit the T2 Web Site to view this document.

New Background Analysis Guidance Document Now Available

According to Navy policy, cleanup efforts at Navy sites should address only those risks associated with chemical concentrations that are elevated as a result of site-related release, not background chemicals. At some sites, unacceptable risks may be associated with chemical concentrations within background range. These risks are outside the scope of the Navy's Environmental Resoration Program; however, they must be identified and conveyed to stakeholders.

The *Guidance for Environmental Background Analysis Volume I: Soil*, now available at the T2 Web Site, provides instructions for characterizing background conditions in soils at remediation sites. Background analysis is necessary to identify background chemicals (those derived from natural or anthropogenic sources not related to activities conducted at the site) and to estimate the chemical concentration ranges that represent the background conditions. The background analysis techniques presented in this document focus on naturally occurring metals, and are based on well-established statistical methods and geochemical relationships. Step-by-step instructions are provided for the data analysis and case studies are presented to illustrate how these analyses are applied.

For further information, contact:

Naval Facilities Engineering Service Center (NFESC), Code 414
Phone: (805) 982-6586

RITS Special Edition

The Fall 2002 Remediation Innovative Technology Seminar (RITS) will offer hands-on training for several internet-based applications and is open to RPMs only. This training will be conducted using computer workstations. Sessions will be half-day. Online registration will be available at http://enviro.nfesc.navy.mil/erb/support/rits/main.htm.

Tools to be demonstrated include Remediation Information Management System (RIMS), Phytoremediation On-line Decision Tree Document, Remediation Technology Evaluation Tool (RTET), Bioslurping Cost Estimating Program, VOC Off-Gas Treatment Technologies Database, and Ex Situ Groundwater Treatment Technologies Evaluation Tool.

EFD/A	2002 Dates
Atlantic Division	8-9 Oct
EFA Northeast	15-16 Oct
EFA Chesapeake	17 Oct Thurs
Southern Division	22-23 Oct
Southwest Division	29-30 Oct
EFA Northwest	31 Oct Thurs
Pacific Division	5-6 Nov

Reminder

Get a head start on your article for upcoming issues of RPM News.

Please provide text, original photos, and/or drawings. Tentative deadlines for each upcoming issue of RPM News are provided below.

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August 15

WINTER 2002
October 24

SPRING 2003
January 6

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